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SEVENTY-SIXTH

ANNUAL REPORT

OF THE

DIRECTOR

OF

THE ASTRONOMICAL OBSERVATORY

OF

HARVARD COLLEGE

FOR THE YEAR ENDING SEPTEMBER 30, 1921

BY

S. I. BAILEY

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CAMBRIDGE, MASS.
PUBLISHED BY THE UNIVERSITY
1922

THE OBSERVATORY

To the President of the University: —

Sir, — The staff of the Astronomical Observatory has suffered serious loss in recent years. Following the death of Professor Pickering, the late Director, in 1919, the Observatory lost two of its members in 1920, Miss Selina C. Bond and Professor Arthur Searle. Miss Bond was the daughter of the first director of the Observatory and an assistant under later directors. Professor Searle was a member of the Observatory for more than forty years and for many years Phillips Professor of Astronomy.

Dr. Harlow Shapley, formerly of the Mount Wilson Observatory, California, was called to this Observatory during the past year, as Observer. He has carried on studies of variable stars, and has made experiments on the measurement of the colors of stars. He finds that cluster type variables exist in the Small Magellanic Cloud. This result is of importance in estimating the distances of globular clusters and in determining the scale of the Galactic System, as it helps to establish the connection between the long period and the short period Cepheid variables, which have been used in his photometric methods of determining great distances.

Dr. Shapley and Miss Cannon are engaged in making a discussion of the distribution of the stars of different spectral types and magnitudes, which occur in the Henry Draper Catalogue.

A new line of work of large extent and of much significance in studies of the structure of the stellar system, and one specially suited to the equipment of the Observatory, is being opened up by the investigations of stellar distances. Several years ago, from a study of Harvard plates, Dr. Shapley found that very good estimates of the distances of stars could be obtained from spectra made with objective prisms. His present association with the Observatory has permitted the further study of this problem. The preliminary results are highly satisfactory. In this research, the value of an observing station in the southern hemisphere is demonstrated. Nearly all of the observatories where stellar distances are measured are located in the northern hemisphere, and the distances of southern stars, as a consequence, are little known. There has, accordingly, been a troublesome incompleteness in the study of the distribution of stars in space. It now appears probable that the Harvard Observatory will be able to fill the need for the distances of southern stars, chiefly by the use of photographs already existing in the Harvard photographic collection.

The systematic photographic survey of the sky for the discovery of new objects of interest has been continued during the year, and two new stars have been discovered by Miss Woods on photographs of the Milky Way. In addition, a large number of new variable stars have been found. Lists of sixty-seven such objects have been published in Circulars 224 and 225, discovered by Misses Cannon, Applegate, Harwood, Mackie, Walker, and Woods.

The astronomical fellowships for women have been filled by Mrs. Mary Applegate Beach and by Miss A. Grace Cook. Mrs. Beach made photographic observations of variable stars. Miss Cook of Stowmarket, England, was engaged in the observation of meteors. This is the first time that the fellowship has been awarded to an English woman.

Dr. Joel H. Metcalf is still engaged in his study of large proper motion with the "Blink" comparator.

Good progress has been made in publication, especially of the Henry Draper Catalogue. Friends of the Observatory have contributed largely to this result. Through the generosity of Mr. and Mrs. C. W. Elmer, an offer of a thousand dollars was made by The American Association of Variable Star Observers to hasten the publication of the Catalogue, with the condition that an equal amount should be received from some other source. This condition was promptly met by Mrs. James R. Jewett, who, in addition, has generously offered to defray the expense of the final volume, H. A. **99**, the ninth volume of the Catalogue. This assures the prompt appearance of the remaining volumes.

HENRY DRAPER MEMORIAL

From an examination of the plates of the Henry Draper Memorial, twenty-seven stars having bright lines in their spectra have been discovered by Miss Cannon, sixteen of which are new variable stars. Two new double stars were found by means of their spectra, and six more of the uncommon stars of Class R.

A special study has also been made by Miss Cannon of the Large Magellanic Cloud. The number of objects having bright lines in their spectra in this region has been increased from forty-eight to sixty-one. The stars of Class O in this Cloud, thirty-three in all, comprise nearly one third of the total number now known to exist in all parts of the sky. Some of them are of the fourteenth magnitude, or three magnitudes fainter than any so far known outside of this Cloud. Five additional stars of the P Cygni type were also found in this survey, the faintest of which is of magnitude 13.2. Numerous stars whose spectra are of Class B, some of which are as faint as the eleventh magnitude, exist in this Cloud.

The spectra of nine variable stars in the Large Cloud were found to belong to Classes from K5 to Mc. While the light curves of these stars have not yet been determined, at least five of them appear to be Cepheids.

A similar study of the Small Magellanic Cloud was made with the result that only one new gaseous nebula was found, making a total of three objects having spectra containing bright lines.

The supervision by Miss Cannon of the printing of the Henry Draper Catalogue has occupied considerable time.

The number of the photographs of the stars made at Cambridge by Professor King or under his direction during the year was 4,427. The total number of plates made was 5,091. The number of successful photographs taken for the position of the Moon was 39. This work was discontinued in April. Plates were also made of Uranus and Neptune, and for the detection of Planet O, according to data furnished by Professor W. H. Pickering.

The work with the 8-inch Draper Telescope, by means of out-of-focus images, for photo-visual magnitudes of bright stars and planets, has been continued. A preliminary reduction of these observations gives the photo-visual magnitudes for forty-four stars, and shows that the color value of this system is slightly toward the red end of the spectrum as compared with the photometric magnitudes of H. A. **50**. Many measures of the photographic magnitudes of the bright planets have also been made. Photographs of the brighter asteroids, when near opposition, have also been taken.

Plates received from Arequipa, which were taken for the photovisual magnitudes of southern stars, have been measured and partly reduced.

The systematic tests of plates and standard lamps have been continued.

Boyden Department

Arequipa Station. — At the end of September, 1920, Mr. F. E. Hinkley, who had been in charge of the Station, was obliged for personal reasons to resign his position and return to the United

States. During the past year, therefore, the Station has been in charge of Señor J. E. Muñiz, who has been the only assistant. He has taken general care of the buildings and equipment, made regular meteorological observations, and carried on photographic work with a portion of the instruments. During the past year he secured altogether 1,214 photographs of the sky, 568 of which were made with the 10-inch Metcalf telescope for the determination of stellar magnitudes.

The stellar photographs obtained at Arequipa in the future as in the past will doubtless continue to play an important part in the plans of the Observatory, and it is hoped that the Station may be placed again on a more efficient basis during the coming year.

Mandeville Station. — The Mandeville Station remains under the direction of Professor W. H. Pickering, who has continued his observations of the Moon and planets. A careful, but unsuccessful, search was made for the suspected transneptunian Planet O, on plates made at Cambridge with the 16-inch Metcalf Telescope. The Station was temporarily closed in April and Professor Pickering left Jamaica for a year's rest and study in Europe, having been granted a sabbatical vacation by the Corporation.

Photographic Magnitudes

The taking and measurement of series plates for the purpose of obtaining the brightness of stars in all parts of the sky on the scale of the North Polar Sequence has been continued under the direction of Miss Leavitt. The number of such plates taken has been smaller than usual, but their quality has been exceptionally good. With the 16-inch Metcalf Telescope at Cambridge, nine series were taken with blue and sixteen series with yellow light, to be used for photographic and photovisual magnitudes, respectively. The number of plates in a series is usually twelve. The northern sky is now so far covered with this instrument that it is usually possible to obtain the approximate magnitude of any star north of declination −15° without much delay. The process of covering the southern sky with the 10-inch Metcalf Telescope at Arequipa is somewhat more than two-thirds completed. The numbers of series taken for photographic and photovisual magnitudes were thirty-one and thirty-four, respectively. About 18,000 measures have been made on series plates, mainly for sequences of stars in the southern heavens. We now have magnitudes on file for about 35,000 stars.

As usual, many requests have been received for magnitudes of particular objects. The observation of variable stars and novae has also continued to be an important activity in this department. The number of such observations has been about 3,000.

VARIABLE STARS

Visual observations of variable stars continue to be an important part of the working program. Mr. Campbell has continued in charge of this department, attending to the correspondence with Variable Star Observers and others outside the Observatory and preparing the monthly Bulletin which keeps observers informed of the stars which require most attention. He has also secured observations with the 12-inch and 15-inch telescopes, when especially needed. Nearly 1,200 estimates of the variables, chiefly during their faint phases, have been made, and 10,824 settings with the photometers attached to these telescopes.

Considerable time has been given to the observation of asteroids, for the detection of variability, and the determination of periods. The photometric settings were 5,662, on eight asteroids, of which Melpomene and Victoria appear to be certainly variable.

Five eclipses of Jupiter's satellites were observed. Special attention has been given to eclipsing variables and to some of the more interesting irregular variables.

The number of observations contributed to the Observatory by professional and amateur astronomers is the largest ever received, 24,018. Of these, 17,325 were communicated by The American Association of Variable Star Observers. Observations of southern variables by Dr. J. M. Baldwin, of Victoria, Australia, and by Mr. J. F. Skjellerup, of South Africa, are of great value. Professor Mitchell, Director of the McCormick Observatory, has continued to furnish observations of the variables when very faint. The detailed list of contributors is as follows:

J. M. Baldwin, 2913; L. C. Peltier, 1889; G. B. Lacchini, 1677; J. F. Skjellerup, 1527; N. V. Ginori, 1253; C. Y. McAteer, 1129; H. C. Bancroft, Jr., 796; R. G. Chandra, 759; The French Variable Star Association, 698; McCormick Observatory, 696; T. C. H. Bouton, 645; Ed. de Perrot, 612; G. Merton, 524; I. Yamamoto, 495; S. L. Rhorer, 467; W. H. F. Waterfield, 427; W. T. Olcott, 423; A. Bemporad, 415; D. B. Pickering, 382; C. S. Mundt, 375; A. S. Young, 350; Ed. Janczewski, 334; J. E. G. Yalden, 283; F. J. Carr, 254; A. W. Long, 225; J. Ellsworth, 215; E. W. Clement, 187; C. E. Barns, 174; C. C. Godfrey, 160; B. H.

Dawson, 150; P. S. Watson, 145; M. J. Jordan, 132; D. Potter, 125; S. K. Proctor, 122; A. E. Schwartz, 118; K. Reesinck, 118; G. C. Waldo, Jr., 115; M. E. Morris, 105; T. S. Kimball, 102; S. C. Hunter, 102. Besides these, 1784 observations were communicated by forty-eight observers, each of whom contributed less than 100.

The discussion of long period variables has been carried forward and considerable data for maxima and minima, as well as for light curves, are available. Predicted dates of maxima and minima continue to be made and appear to satisfy a real need.

Construction and Equipment

The plant and equipment have remained in charge of Professor Gerrish, who has continued to act as adviser in matters pertaining to engineering, and has also served as business executive.

An electrically driven vacuum apparatus has been installed in connection with the 16-inch Metcalf Telescope for springing photographic plates to a spherical curvature while in the telescope.

Indicating apparatus for the two-foot reflector has been designed and is under construction, by which the position of the telescope may be read from the observing deck above the instrument.

A simple instrument known as the Pole Finder has been devised, by which the position of the celestial Pole may be determined directly, and with moderate accuracy. The instrument is in two forms: one in which the eye is used unaided by optical devices; the other in which a small telescope serves to increase the accuracy of the determination.

A new visual method has been developed for adjusting the polar axis of an equatorial. A single adjustment, based upon two observations of Polaris, brings the axis accurately upon the Pole. Circumpolar stars are particularly advantageous for this purpose, affording a maximum degree of accuracy in both coördinates, but, owing to the difficulty of utilizing visual observations, their use hitherto has been confined almost entirely to photographic methods in which a large number of successive adjustments are required.

Miscellaneous

Phillips Library. — Nine hundred and forty volumes and pamphlets have been added to the Library during the year, making the total number at the present date 58,156.

Telegraphic Announcements. — This Observatory has continued to act as the American centre of the International Astronomical Union for the distribution of astronomical news, both domestic and foreign. During the year seventeen telegraphic announcements were made. Cablegrams from any part of North or South America should be addressed to Observatory, Boston, and telegrams, to Harvard College Observatory, Cambridge, Mass. Twenty-seven Bulletins have been issued, making 758 in all. These Bulletins in general supplement the telegraphic service. They serve for the announcement of new stars, comets, variable stars, and any other important astronomical news.

Publications. — The following Annals have been published during the year: — **81**, No. 5, Photographic Determinations of the Position of the Moon; **83**, No. 5, Observations and Investigations made at the Blue Hill Meteorological Observatory in the year 1920; and **95**, The Henry Draper Catalogue, 12^h, 13^h, and 14^h. **96**, 15^h and 16^h of The Henry Draper Catalogue, has been printed and is ready to send out, and **97**, 17^h and 18^h of the same Catalogue, is all in type. Five Circulars have been issued, as follows:

222. Predicted Maxima and Minima in 1921 of Variable Stars. December 15, 1920.
223. Observations of Saturn's Rings. January 3, 1921.
224. Stars Having Peculiar Spectra. 16 New Variable Stars. March 23, 1921.
225. Fifty-one New Variable Stars. May 2, 1921.
226. On the Relation of Spectral Type to Magnitude. July 30, 1921.

S. I. BAILEY, *Acting Director.*

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